

PRELIMINARY DATA SUMMARY

May 1991

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

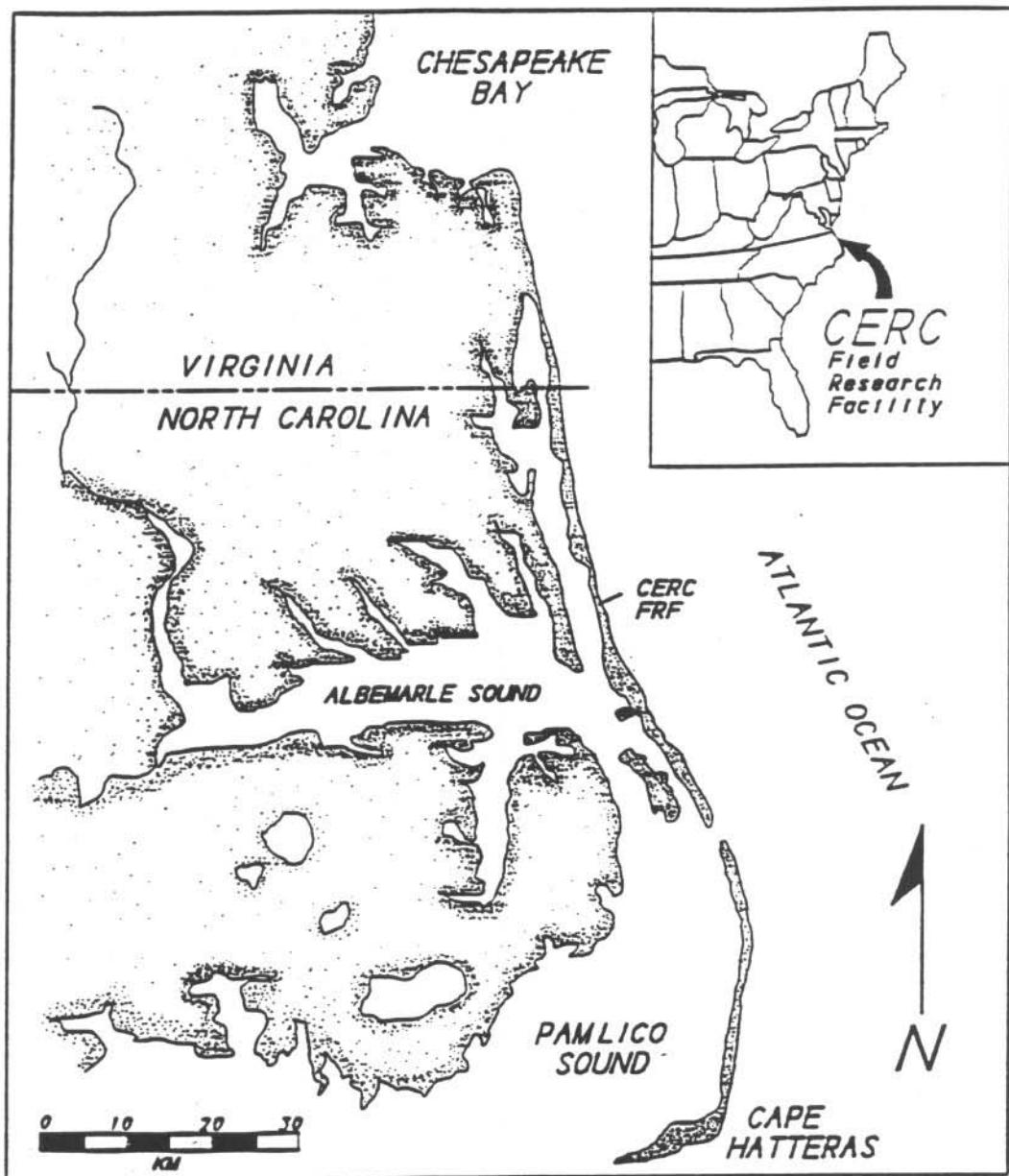


Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

MAY 1991

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

True North

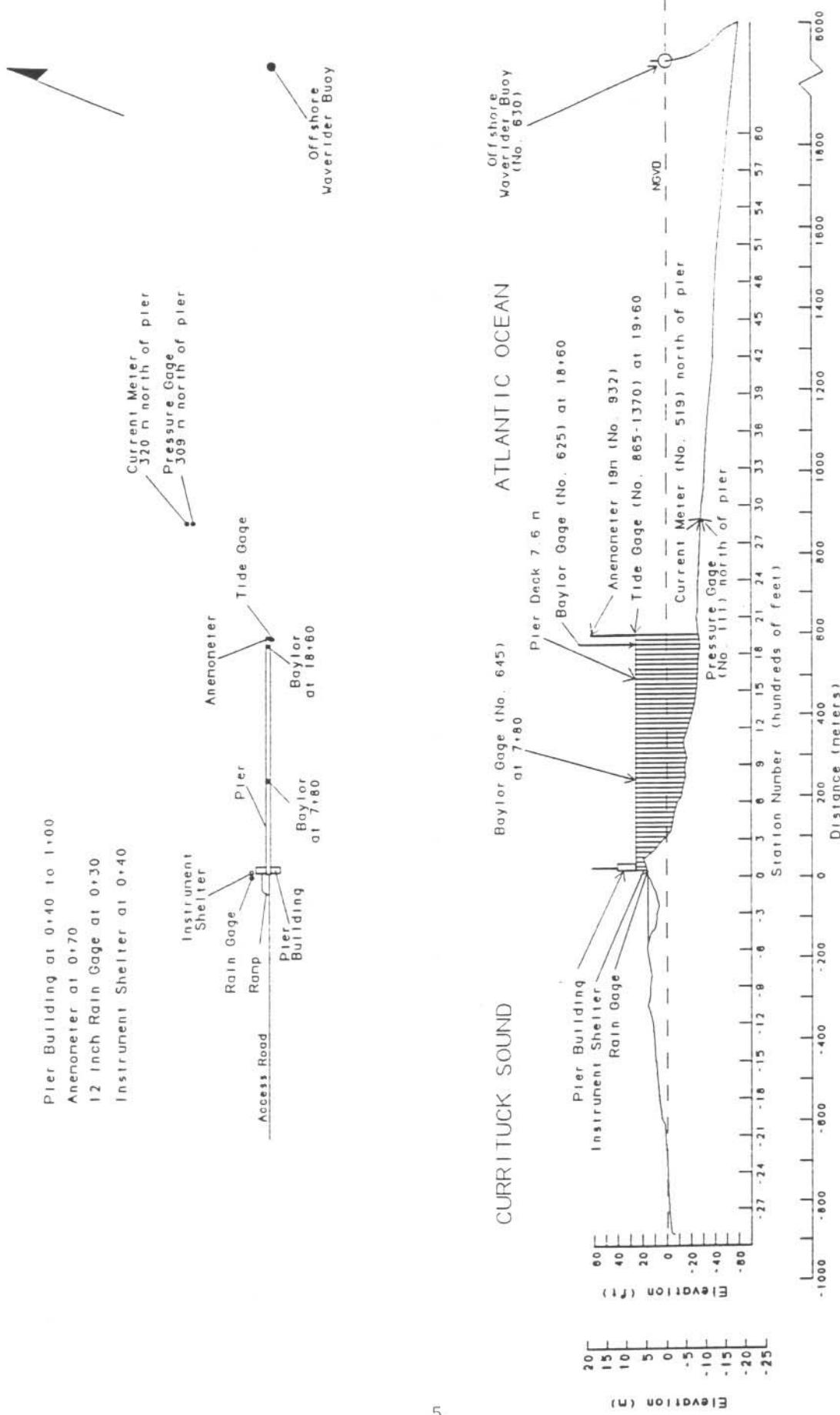


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

May 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	6	223	20.7	1011.8	0
	700	4	260	20.5	1012.5	0
	1300	5	108	23.6	1010.4	0
	1900	7	191	23.6	1006.7	0
2	100	8	245	22.0	1006.4	0
	700	7	324	17.1	1010.8	0
	1300	2	83	20.2	1011.4	0
	1900	6	254	20.8	1010.4	0
3	100	3	263	17.0	1010.4	0
	700	9	251	19.5	1010.8	0
	1300	11	2	16.8	1012.8	0
	1900	5	60	14.5	1013.1	0
4	100	2	95	14.5	1013.8	0
	700	2	61	15.2	1015.5	0
	1300	5	62	16.3	1016.2	0
	1900	6	86	14.4	1015.9	0
5	100	6	100	15.4	1016.5	0
	700	5	82	17.1	1017.9	0
	1300	6	101	19.3	1017.5	0
	1900	5	117	17.8	1015.9	0
6	100	6	174	21.1	1014.8	0
	700	8	192	21.7	1013.8	0
	1300	8	198	26.2	1011.8	0
	1900	8	184	23.4	1012.1	0
7	100	8	221	22.1	1013.5	0
	700	6	295	21.1	1017.2	0
	1300	7	33	16.0	1020.3	0
	1900	5	89	15.1	1021.3	0
8	100	2	123	14.1	1022.3	0
	700	3	38	16.3	1025.0	0
	1300	3	100	19.8	1024.7	0
	1900	4	123	17.1	1023.0	0
9	100	2	140	15.7	1022.3	0
	700	3	87	17.9	1023.0	0
	1300	3	73	19.5	1023.6	0
	1900	4	68	16.4	1022.6	0
10	100	3	59	16.9	1021.6	0
	700	2	101	17.7	1021.6	0
	1300	2	71	22.4	1020.9	0
	1900	2	89	18.7	1019.9	0
11	100	8	61	15.3	1021.9	0
	700	8	56	17.1	1023.3	0
	1300	5	36	19.1	1023.3	0
	1900	3	69	15.8	1020.6	0
12	100	3	141	15.6	1018.6	0
	700	5	209	19.3	1017.5	0
	1300	6	239	26.1	1013.5	0
	1900	6	193	24.1	1011.1	0
13	100	7	223	21.8	1011.1	0
	700	7	230	21.7	1011.8	0
	1300	7	210	28.2	1010.1	0
	1900	5	228	24.7	1008.7	0
14	100	8	225	21.8	1009.1	0
	700	8	219	22.9	1009.8	0
	1300	7	185	28.9	1008.4	0
	1900	7	193	24.4	1008.1	0
15	100	6	189	23.1	1008.1	0
	700	3	240	23.3	1009.4	0
	1300	5	18	23.0	1010.8	0
	1900	6	46	19.7	1012.1	0
16	100	5	344	17.3	1013.8	0
	700	4	39	17.4	1015.9	0
	1300	4	49	22.9	1016.5	0
	1900	5	70	20.8	1014.8	0

* electronic problems

(Continued)

Table 2: Meteorological Data

May 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
17	100	1	92	20.9	1014.8	0
	700	3	109	22.4	1014.5	0
	1300	6	96	28.9	1012.8	0
	1900	6	170	29.2	1011.1	0
18	100	7	215	27.4	1011.8	0
	700	3	248	27.7	1014.2	0
	1300	13	6	23.1	1017.5	0
	1900	12	8	20.2	1020.3	0
19	100	13	7	19.9	1021.3	0
	700	14	21	20.6	1021.9	0
	1300	13	30	19.9	1023.6	0
	1900	12	26	19.5	1023.0	0
20	100	12	18	20.1	1022.3	0
	700	10	20	20.3	1023.3	0
	1300	8	30	20.8	1023.6	0
	1900	6	28	20.9	1022.6	2
21	100	6	26	21.1	1022.3	0
	700	8	28	22.1	1023.6	0
	1300	5	42	24.5	1023.0	0
	1900	4	73	22.7	1021.3	0
22	100	3	90	21.9	1020.9	0
	700	3	92	24.0	1020.9	0
	1300	3	39	27.3	1019.9	0
	1900	7	178	25.7	1018.6	0
23	100	5	200	24.2	1019.2	0
	700	4	214	25.0	1020.3	0
	1300	6	131	28.3	1020.3	0
	1900	5	166	25.5	1018.9	0
24	100	4	156	22.9	1019.9	0
	700	2	139	25.4	1020.9	0
	1300	6	128	27.0	1018.9	0
	1900	7	176	26.3	1016.9	0
25	100	5	199	25.3	1016.5	0
	700	3	204	26.4	1017.2	0
	1300	6	128	28.8	1015.9	0
	1900	7	176	28.3	1014.2	0
26	100	4	203	26.7	1015.9	0
	700	5	210	27.7	1017.2	0
	1300	6	136	28.5	1016.9	0
	1900	7	150	24.8	1016.2	0
27	100	6	192	27.3	1017.2	0
	700	5	195	28.3	1017.9	0
	1300	7	189	32.1	1016.5	0
	1900	7	190	30.0	1015.2	0
28	100	9	207	27.7	1015.5	0
	700	9	229	27.9	1015.2	0
	1300	6	231	32.3	1014.8	0
	1900	3	271	27.4	1013.5	5
29	100	4	315	27.0	1013.8	0
	700	5	328	28.3	1012.8	0
	1300	4	15	27.7	1013.1	0
	1900	3	84	25.5	1011.4	0
30	100	2	188	25.8	1010.4	0
	700	2	182	29.0	1010.4	0
	1300	7	149	29.7	1009.4	0
	1900	8	187	30.1	1007.4	0
31	100	8	225	28.7	1007.4	0
	700	8	240	28.9	1007.4	0
	1300	4	226	33.9	1006.7	0
	1900	4	236	32.5	1005.0	0
		<u>Resultant</u>		<u>Mean</u>	<u>Mean</u>	<u>Total</u>
		1	146	22.7	1015.9	7

* electronic problems

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

May 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo.m T.sec	Baylor at 18+60	Hmo.m T.sec	Pressure Gage	Hmo.m T.sec	Offshr Wvdr	Hmo.m T.sec
1	0100	0.27	14.22	0.48	13.47	0.51	13.47	0.55	13.47
	0700	0.35	12.80	0.44	12.80	0.46	13.47	0.47	13.47
	1300	0.31	13.47	0.41	12.80	0.45	13.47	0.43	12.80
	1900	0.32	12.80	0.39	11.64	0.41	12.80	0.49	12.19
2	0100	0.28	13.47	0.34	12.80	0.36	12.19	0.43	13.47
	0700	0.48	12.80	0.50	12.80	0.35	12.80	0.52	12.80
	1300	0.39	12.80	0.36	12.80	0.38	12.80	0.51	12.80
	1900	0.36	13.47	0.40	13.47	0.44	12.80	0.52	12.19
3	0100	0.33	13.47	0.40	13.47	0.39	12.19	0.41	12.80
	0700	0.31	12.80	0.32	12.80	0.36	12.19	0.52	2.41
	1300	0.92	3.94	0.73	3.66	0.65	3.77	0.83	3.94
	1900	0.89	5.33	0.68	5.12	0.67	4.74	0.89	5.12
4	0100	0.52	5.95	0.39	5.82	0.41	5.82	0.53	5.12
	0700	0.33	4.74	0.33	9.85	0.36	11.64	0.42	4.00
	1300	0.46	2.69	0.43	2.51	0.35	9.48	0.46	3.16
	1900	0.52	2.72	0.47	2.91	0.36	3.88	0.50	4.83
5	0100	0.58	5.82	0.55	3.41	0.50	3.46	0.70	6.09
	0700	0.36	5.02	0.47	5.22	0.43	5.22	0.61	5.22
	1300	0.46	4.49	0.46	4.49	0.42	6.74	0.60	4.49
	1900	0.44	5.12	0.45	11.13	0.43	5.02	0.67	4.92
6	0100	0.45	5.12	0.50	5.22	0.45	5.33	0.72	5.12
	0700	0.54	5.33	0.72	5.45	0.70	5.82	0.87	5.45
	1300	0.51	5.33	0.56	5.69	0.57	5.45	0.88	5.02
	1900	0.31	5.33	0.49	7.11	0.47	3.33	0.67	7.11
7	0100	0.41	5.82	0.45	6.74	0.42	6.24	0.57	6.40
	0700	0.26	6.24	0.34	6.74	0.37	6.40	*	
	1300	0.99	4.41	0.87	4.41	0.90	4.34	0.92	4.41
	1900	0.61	4.83	0.65	4.83	0.61	4.66	0.76	4.74
8	0100	0.47	4.49	0.52	4.83	0.55	4.83	0.63	6.40
	0700	0.41	10.67	0.44	7.76	0.44	7.76	0.50	6.56
	1300	0.39	10.24	0.43	11.13	0.44	8.26	0.51	5.95
	1900	0.26	5.82	0.42	5.95	0.44	5.69	0.49	5.45
9	0100	0.37	5.57	0.41	5.45	0.45	5.69	0.49	6.09
	0700	0.30	5.33	0.41	5.69	0.46	10.67	0.48	5.12
	1300	0.34	5.33	0.38	10.24	0.44	10.67	0.48	5.12
	1900	0.50	3.82	0.58	3.66	0.50	3.61	0.67	3.66
10	0100	0.58	5.02	0.52	3.77	0.53	3.51	0.63	5.45
	0700	0.41	4.92	0.51	4.83	0.54	4.74	0.62	4.83
	1300	0.46	5.33	0.44	7.76	0.51	8.00	0.57	7.11
	1900	0.39	8.53	0.39	8.00	0.45	7.76	0.50	7.76
11	0100	0.95	4.83	0.99	4.49	1.04	4.66	1.14	4.27
	0700	1.03	4.92	1.04	4.74	1.04	5.12	1.20	5.02
	1300	1.04	5.95	1.07	8.00	1.10	8.26	1.13	6.09
	1900	0.70	4.92	0.79	7.76	0.78	8.53	0.87	7.76
12	0100	0.58	9.85	0.80	9.85	0.81	9.48	0.75	9.85
	0700	0.60	8.83	0.72	8.53	0.82	8.83	0.73	9.14
	1300	0.51	9.48	0.76	7.76	0.84	7.53	0.88	9.14
	1900	0.50	9.85	0.68	9.85	0.74	9.48	0.80	9.14
13	0100	0.51	10.24	0.60	10.24	0.64	10.24	0.67	10.24
	0700	0.35	9.85	0.44	10.24	0.51	10.67	0.61	9.85
	1300	0.39	12.19	0.47	9.85	0.51	10.67	0.56	10.67
	1900	0.31	11.13	0.42	10.67	0.46	10.67	0.53	11.13
14	0100	0.37	10.67	0.45	10.24	0.42	11.13	0.52	11.13
	0700	0.27	9.85	0.37	10.67	0.35	10.67	0.43	9.85
	1300	0.33	9.48	0.30	10.67	0.31	9.85	0.38	10.24
	1900	0.25	9.85	0.29	9.85	0.29	9.85	0.48	9.48
15	0100	0.28	9.48	0.25	9.48	0.24	9.48	0.32	9.14
	0700	0.28	4.83	0.31	9.85	0.30	4.34	0.41	4.06
	1300	0.33	5.45	0.29	9.48	0.29	6.24	0.36	5.82
	1900	0.49	3.20	0.53	3.20	0.33	3.66	0.63	3.46
16	0100	0.50	3.56	0.57	3.88	0.52	3.61	0.70	4.00
	0700	0.64	4.66	0.61	4.57	0.63	4.20	0.76	4.66
	1300	0.65	4.66	0.58	4.57	0.61	4.41	0.69	4.20
	1900	0.55	4.49	0.72	5.69	0.66	5.12	0.80	5.57

* Electronic problems

(Continued)

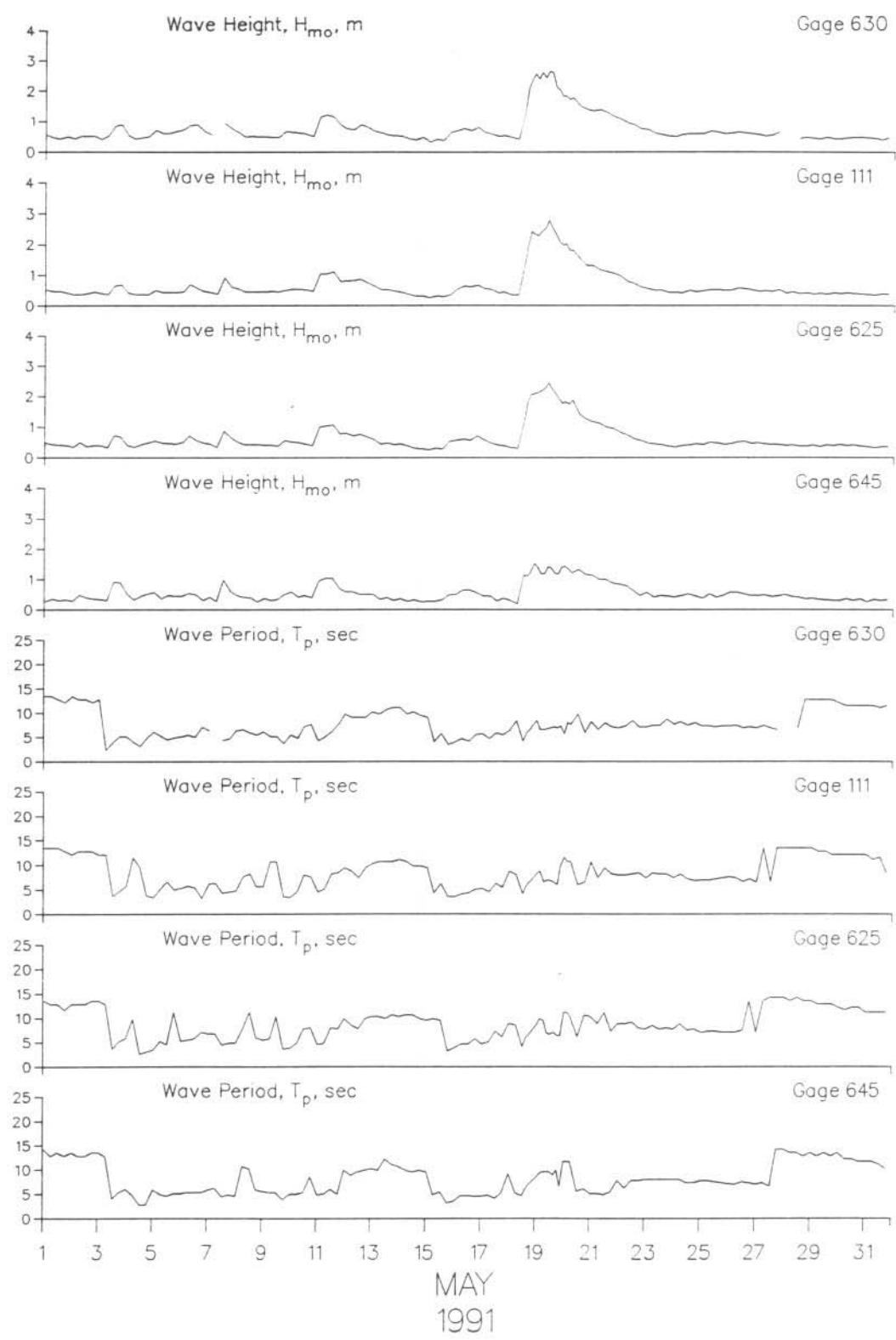
Table 3: Wave Data

May 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo.m T.sec	Baylor at 18+60	Hmo.m T.sec	Pressure Gage	Hmo.m T.sec	Offshrd Wvrdr	Hmo.m T.sec
17	0100	0.44	4.57	0.58	4.57	0.55	5.22	0.63	5.69
	0700	0.45	4.74	0.48	5.12	0.52	4.66	0.59	4.74
	1300	0.29	4.13	0.41	7.31	0.41	6.40	0.51	5.95
	1900	0.38	5.22	0.39	6.09	0.43	5.45	0.53	5.45
18	0100	0.30	9.14	0.32	8.83	0.34	8.83	0.47	6.40
	0700	0.17	5.22	0.30	8.53	0.34	8.00	0.40	8.53
	1300	1.15	4.66	1.20	4.06	1.33	4.20	1.22	4.13
	1900	1.24	6.92	2.07	6.56	2.41	6.74	2.35	6.56
19	0100	1.39	8.26	2.14	8.53	2.29	8.26	2.39	8.53
	0700	1.19	9.48	2.28	9.48	2.52	6.56	2.41	6.56
	1300	1.38	9.48	2.24	6.56	2.54	6.92	2.62	6.92
	1900	1.18	9.85	1.93	6.40	2.09	6.09	2.03	6.92
20	0100	1.43	11.64	1.81	11.13	2.00	11.64	1.81	5.69
	0700	1.22	11.64	1.88	10.24	1.79	10.67	1.76	7.76
	1300	1.33	5.57	1.43	6.09	1.53	6.09	1.49	9.85
	1900	1.16	6.09	1.27	10.67	1.30	6.56	1.39	5.95
21	0100	1.15	5.12	1.17	10.24	1.29	10.67	1.33	8.26
	0700	1.01	5.12	1.12	8.83	1.15	7.53	1.36	6.56
	1300	1.00	4.83	1.00	11.13	1.10	9.48	1.27	8.00
	1900	0.88	5.45	0.96	7.31	1.05	8.26	1.15	7.11
22	0100	0.84	7.76	0.84	8.83	0.96	8.00	1.06	6.92
	0700	0.79	6.24	0.75	8.83	0.78	8.00	0.95	7.31
	1300	0.63	7.76	0.62	9.14	0.72	8.26	0.88	8.53
	1900	0.47	7.76	0.58	8.00	0.60	8.53	0.75	7.11
23	0100	0.57	8.00	0.48	7.76	0.55	7.53	0.72	7.11
	0700	0.41	8.00	0.45	8.53	0.50	8.53	0.60	7.53
	1300	0.46	8.00	0.42	7.76	0.50	8.26	0.56	7.53
	1900	0.45	8.00	0.38	8.00	0.43	8.26	0.50	8.83
24	0100	0.41	8.00	0.34	7.76	0.43	7.53	0.50	7.76
	0700	0.47	8.00	0.39	8.83	0.41	8.26	0.57	8.26
	1300	0.51	7.31	0.42	7.53	0.50	7.31	0.58	7.53
	1900	0.45	7.31	0.44	7.76	0.44	6.92	0.59	8.00
25	0100	0.37	7.76	0.44	6.92	0.48	7.11	0.58	7.31
	0700	0.53	7.76	0.50	7.31	0.52	7.11	0.67	7.31
	1300	0.41	7.53	0.49	7.31	0.52	7.31	0.64	7.11
	1900	0.47	7.31	0.44	7.11	0.50	7.53	0.59	7.31
26	0100	0.57	7.11	0.45	7.11	0.49	7.76	0.59	7.31
	0700	0.57	6.92	0.51	7.11	0.57	7.53	0.64	7.53
	1300	0.52	7.53	0.53	7.53	0.56	6.74	0.62	6.92
	1900	0.46	7.31	0.46	13.47	0.51	7.31	0.59	7.11
27	0100	0.46	6.92	0.48	7.11	0.46	6.56	0.56	6.92
	0700	0.49	7.31	0.45	13.47	0.48	13.47	0.52	7.53
	1300	0.43	6.56	0.42	14.22	0.46	6.74	0.54	6.92
	1900	0.44	14.22	0.42	14.22	0.51	13.47	0.63	6.56
28	0100	0.50	14.22	0.38	14.22	0.41	13.47	*	
	0700	0.44	13.47	0.41	13.47	0.44	13.47	1.68	15.06
	1300	0.41	13.47	0.38	14.22	0.38	13.47	0.44	6.92
	1900	0.36	12.80	0.38	13.47	0.40	13.47	0.48	12.80
29	0100	0.38	13.47	0.42	13.47	0.38	13.47	0.43	12.80
	0700	0.35	12.80	0.36	12.80	0.40	12.80	0.42	12.80
	1300	0.32	13.47	0.41	12.80	0.37	12.80	0.48	12.80
	1900	0.31	12.80	0.39	12.80	0.41	12.19	0.42	12.80
30	0100	0.31	13.47	0.43	12.19	0.38	12.19	0.43	12.19
	0700	0.35	12.19	0.40	11.64	0.41	12.19	0.46	11.64
	1300	0.31	12.19	0.41	12.19	0.40	12.19	0.47	11.64
	1900	0.35	11.64	0.38	12.19	0.37	12.19	0.48	11.64
31	0100	0.25	11.64	0.35	11.13	0.35	12.19	0.46	11.64
	0700	0.34	11.64	0.33	11.13	0.35	11.13	0.44	11.64
	1300	0.30	11.13	0.35	11.13	0.37	11.64	0.39	11.13
	1900	0.33	10.24	0.36	11.13	0.38	8.53	0.46	11.64
Mean		0.54	8.08	0.61	8.64	0.64	8.36	0.74	7.79
Std dev		0.29	3.22	0.42	3.11	0.46	3.02	0.44	2.87

* Electronic problems

(Sheet 2 of 2)



PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)	Dye at Zone (surface)	Distance from Baseline (m)	Speed	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
1 0100-Along Cross Result								3 5 6	S off 101
1 0700-Along Cross Result	9 2 10	N off 354		9 3 9	N off 359	South	7 S	3 0 3	S 160
1 1300-Along Cross Result								5 13 14	S off 91
1 1900-Along Cross Result								5 1 5	S on 171
2 0100-Along Cross Result								4 2 4	S off 133
2 0700-Along Cross Result	28 7 29	S on 174	165	30 0 30	S North	22 S	22 16 16	4 16 16	S off 84
2 1300-Along Cross Result								11 19 22	S off 100
2 1900-Along Cross Result								3 3 4	S on 205
3 0100-Along Cross Result								8 13 15	S off 102
3 0700-Along Cross Result	14 14 19	S off 115	165	15 4 15	S off 146	North	7 S	9 9 13	S off 115
3 1300-Along Cross Result								15 28 32	S off 98
3 1900-Along Cross Result								9 8 12	S off 118
4 0100-Along Cross Result								2 0 2	S off 160
4 0700-Along Cross Result	8 6 10	N off 17	165	7 0 7	S North	6 S	8 2 8	8 off 146	S off 146
4 1300-Along Cross Result								10 19 21	S off 98
4 1900-Along Cross Result								7 0 7	S off 160
5 0100-Along Cross Result								2 4 4	S on 223
5 0700-Along Cross Result	17 0 17	N 165		7 2 7	N on 323	South	6 N	7 9 11	S on 212
5 1300-Along Cross Result								13 5 14	S off 139
5 1900-Along Cross Result								12 5 13	S off 137

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter		
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6 0100-Along Cross Result										13	S
6 0700-Along Cross Result	61 0	N 340		177	47 23 52	N off 7		18	N	1	on
6 1300-Along Cross Result										13	164
6 1900-Along Cross Result										14	S
7 0100-Along Cross Result										1	off
7 0700-Along Cross Result	17 3	S off		177	20 2 20	S off 154		7	S	14	156
7 1300-Along Cross Result										13	S
7 1900-Along Cross Result										2	on
8 0100-Along Cross Result										13	169
8 0700-Along Cross Result	41 10 42	S on 174		177	22 7 23	S on 177		8	S	8	201
8 1300-Along Cross Result										7	on
8 1900-Along Cross Result										11	120
9 0100-Along Cross Result										9	S
9 0700-Along Cross Result	27 3 27	N on 334		177	23 2 23	N on 334		7	N	8	202
9 1300-Along Cross Result										10	S
9 1900-Along Cross Result										12	171
10 0100-Along Cross Result										11	off
10 0700-Along Cross Result	3 1 3	N on 326		177	14 4 14	N on 323		7	N	23	99
10 1300-Along Cross Result										20	S
10 1900-Along Cross Result										23	off

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed Dir	Dye 12m offshore (surface)	Location	Speed Dir	0.9 km Offshore (NGVD) Depth -5.6m ID #519	Dir
11 0100-Along Cross Result								5	S
								6	off
								8	110
11 0700-Along Cross Result	18 0	S	201	0 0	8 S	North	2 5 5	N on 272	
11 1300-Along Cross Result								6 5 8	S off 120
11 1900-Along Cross Result								3 7 8	S off 93
12 0100-Along Cross Result								1 7 7	N on 258
12 0700-Along Cross Result	12 13	N off	177	24 2 25	N off 346	South	25 N	2 6 6	N on 268
12 1300-Along Cross Result								3 10 10	N on 267
12 1900-Along Cross Result								5 11 12	N on 274
13 0100-Along Cross Result								2 8 8	N on 264
13 0700-Along Cross Result	15 9	N off	165	0 8 8		South	5 N	1 5 5	S on 239
13 1300-Along Cross Result								1 5 5	N on 261
13 1900-Along Cross Result								9 11 14	N on 289
14 0100-Along Cross Result								1 3 3	N on 268
14 0700-Along Cross Result	9 9	N off	165	0 4 4		South	9 N	1 2 2	S on 223
14 1300-Along Cross Result								1 4 4	N on 264
14 1900-Along Cross Result								1 4 4	N on 264
15 0100-Along Cross Result								0 3 3	on 250
15 0700-Along Cross Result	6 3	S off	165	4 7	S off	North	7 S	1 2 2	N on 277
15 1300-Along Cross Result								1 1 1	N off 25
15 1900-Along Cross Result								3 1 3	S on 178

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
May 1991

Day	Time	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519	Speed
16	0100-Along Cross Result									1	S
										7	off
										7	78
16	0700-Along Cross Result	41 6 on	S 169	165	16 5 on	12m offshore (surface)	North	14	S	4	S
		41	169		17	177				12	off
										13	88
16	1300-Along Cross Result									5	S
										14	off
										15	90
16	1900-Along Cross Result									6	S
										14	off
										15	93
17	0100-Along Cross Result									6	S
										3	off
										7	133
17	0700-Along Cross Result	14 4 on	S 174	165	6 2 on	12m offshore (surface)	North	7	S	2	S
		15	174		7	174				1	on
										2	187
17	1300-Along Cross Result									2	S
										3	on
										4	216
17	1900-Along Cross Result									4	N
										11	on
										12	270
18	0100-Along Cross Result									0	
										4	on
										4	250
18	0700-Along Cross Result	16 0	N 340	165	7 0	12m offshore (surface)	South	4	S	2	N
		16	340		7	340				4	on
										4	277
18	1300-Along Cross Result									3	S
										5	off
										6	101
18	1900-Along Cross Result									15	S
										28	off
										32	98
19	0100-Along Cross Result									19	S
										37	off
										42	97
19	0700-Along Cross Result	47 0	S 160	165	102 0	12m offshore (surface)	no observation			16	S
		47	160		102	160				29	off
										33	99
19	1300-Along Cross Result									17	S
										30	off
										34	100
19	1900-Along Cross Result									12	S
										20	off
										23	101
20	0100-Along Cross Result									17	S
										28	off
										33	101
20	0700-Along Cross Result	32 8	S on	177	76 0	12m offshore (surface)	North	8	N	13	S
		33	174		76	160				16	off
										21	109
20	1300-Along Cross Result									9	S
										13	off
										16	105
20	1900-Along Cross Result									7	S
										3	off
										8	137

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Dye at Mid-Surf Zone (surface)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
21 0100-Along Cross Result								0		
								2		
								2	on	
21 0700-Along Cross Result	0 11 11	— on 250	201	30 15 34	N on 313	South	17	N	3 0 3	S 160
21 1300-Along Cross Result								2		N
								8		on
								8		264
21 1900-Along Cross Result								2		S
								8		on
								8		236
22 0100-Along Cross Result								6		N
								13		on
								14		275
22 0700-Along Cross Result	44 7 44	N on 331	189	41 0 41	N 0 340	South	12	N	3 10 10	N on 267
22 1300-Along Cross Result								5		N
								13		on
								14		271
22 1900-Along Cross Result								3		N
								9		on
								9		268
23 0100-Along Cross Result								5		N
								14		on
								15		270
23 0700-Along Cross Result	10 10 14	N off 25	177	10 3 10	N off 354	South	23	N	1 8 8	N on 257
23 1300-Along Cross Result								1		N
								6		on
								6		259
23 1900-Along Cross Result								4		S
								1		on
								4		174
24 0100-Along Cross Result								1		S
								5		on
								5		239
24 0700-Along Cross Result	4 8 9	N on 278	152	15 5 16	N on 323	South	8	N	0 0 0	
24 1300-Along Cross Result								1		S
								3		on
								3		232
24 1900-Along Cross Result								2		S
								4		on
								4		223
25 0100-Along Cross Result								2		N
								10		on
								10		261
25 0700-Along Cross Result	5 8 9	N off 36	189	8 10 13	N off 31	South	10	N	6 8 10	N on 287
25 1300-Along Cross Result								4		N
								10		on
								11		272
25 1900-Along Cross Result								4		N
								7		on
								8		280

KEY = All speeds in cm/sec
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 on = onshore off = offshore

Table 4: Current Data (Continued)
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements				Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519	
26 0100-Along Cross Result									3	N
									11	on
									11	265
26 0700-Along Cross Result	23 0	N 340			21 0	N 340			2	N
									7	on
									7	266
26 1300-Along Cross Result									4	N
									6	on
									7	284
26 1900-Along Cross Result									0	
									7	on
									7	250
27 0100-Along Cross Result									2	N
									7	on
									7	266
27 0700-Along Cross Result	15 8	N off	177		12 6	N off			3	S
									7	on
									8	227
27 1300-Along Cross Result	17	7			13	7			6	N
									9	on
									11	284
27 1900-Along Cross Result									1	N
									7	on
									7	258
28 0100-Along Cross Result									1	N
									10	on
									10	256
28 0700-Along Cross Result	0				0				0	
	10	off	177		9	off			8	on
	10	70			9	70			8	250
28 1300-Along Cross Result									0	
									5	on
									5	250
28 1900-Along Cross Result									2	N
									10	on
									10	261
29 0100-Along Cross Result									1	N
									6	on
									6	259
29 0700-Along Cross Result	14 0	S 160	165		18 0	S 160		0	3	N
									6	on
									7	277
29 1300-Along Cross Result	14	160							1	S
									1	off
									1	115
29 1900-Along Cross Result									3	S
									1	off
									3	142
30 0100-Along Cross Result									5	S
									1	off
									5	149
30 0700-Along Cross Result	19 10	S off	165		6 0	S 160		7	2	S
									2	on
									3	205
30 1300-Along Cross Result	21	133							2	N
									3	on
									4	284
30 1900-Along Cross Result									2	N
									6	on
									6	268

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Concluded)
May 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline		Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519	
Speed	Dir	(m)	Speed	Dir	Location	Speed	Dir	Speed	Dir	
31 0100-Along Cross Result								0		
								4	on	
								4	250	
31 0700-Along Cross Result	0 8 8	— off 70	177	0 16 16	— off 70	North	0	0 5 5	on 250	
31 1300-Along Cross Result	— — —	— — —	— — —	— — —	— — —	— — —	— — —	1 1 1	N on 295	
31 1900-Along Cross Result	— — —	— — —	— — —	— — —	— — —	— — —	— — —	1 7 7	N on 258	

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

May 1991

Day	Time	Wave Approach			Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary	Radar Wave Angle deg from True N		Temp., C	Density g/cc	Secchi Vis., m
1	0706	130			10	15.0	1.0210	2.4
2	0737	15		55	7	14.4	1.0222	3.4
3	0724	90			1	17.2	1.0200	3.0
4	0727	20			6	17.2	1.0202	2.4
5	0746	50	115	90	9	17.2	1.0198	3.0
6	0736	100	140		14	16.1	1.0212	3.0
7	0710	110			6	12.8	1.0238	3.0
8	0713	60	110	45	14	17.8	1.0180	2.7
9	0741	100			7	18.3	1.0180	2.1
10	0649	115			14	18.9	1.0180	2.1
11	0822	65	90	80	174	19.4	1.0179	2.7
12	0853	95			134	18.3	1.0204	1.8
13	0730	80			6	15.0	1.0231	2.1
14	0744	110		90	6	13.3	1.0240	1.5
15	0745	120			5	13.3	1.0240	2.1
16	0750	40		45	6	18.9	1.0224	6.1
17	0712	110			6	22.8	1.0184	2.7
18	0812	120			12	20.6	1.0210	4.3
19	0930	65	35	60	299	20.0	1.0200	0.9
20	0747	70	30	65	195	18.9	1.0198	0.6
21	0722	90	65	80	168	18.9	1.0190	0.6
22	0814	100			157	18.9	1.0204	1.8
23	0728	115			12	17.8	1.0214	2.1
24	0736	100	120		52	18.9	1.0213	2.7
25	0724	110			12	17.8	1.0226	1.8
26	1116	105			8	18.3	1.0231	1.8
27	0942	110			14	16.7	1.0232	1.5
28	0754	125			12	15.6	1.0236	1.8
29	0755	110			8	18.9	1.0226	3.7
30	0804	110			8	23.3	1.0186	3.4
31	0729	110			9	15.6	1.0235	2.4

PART VI: WATER LEVELS

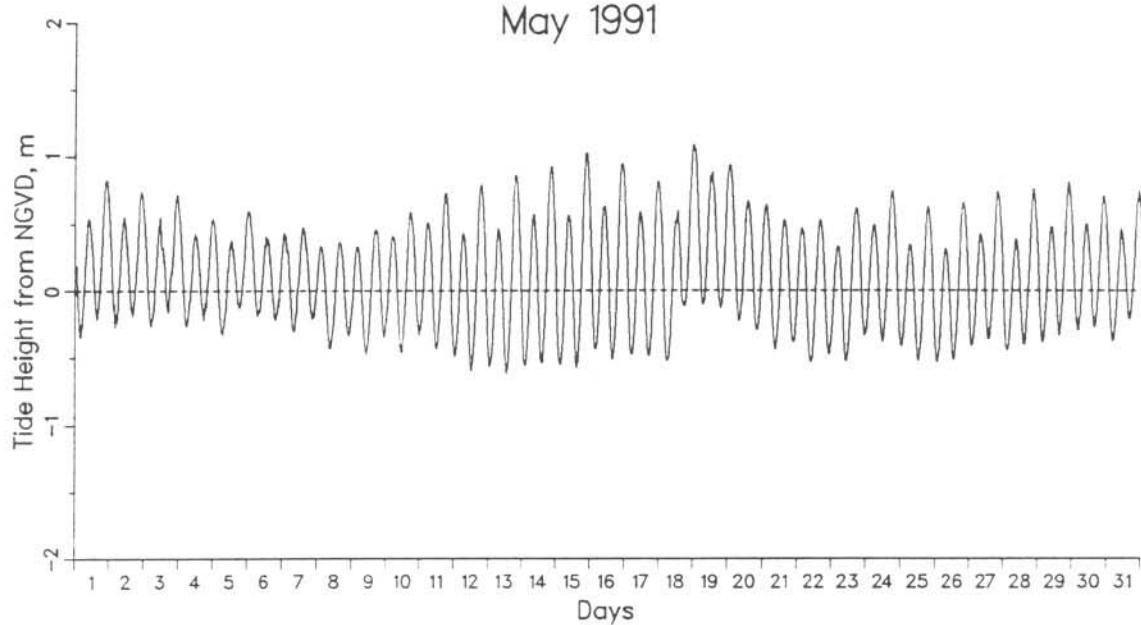
Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights

May 1991



Monthly Water Levels, m NGVD

Extreme Low = -0.62 on day 13 at 1154 EST
Extreme High = 1.09 on day 18 at 2248 EST
Monthly Mean = 0.12
Mean Low = -0.37
Mean High = 0.60
Mean Range = 0.97

Table 6: Water Levels.m NGVD

		May 1991			
Day	Mid-Cycle Time	Low	High	Mean	Range
1	530	-0.35	0.54	0.12	0.89
1	1755	-0.21	0.83	0.32	1.04
2	620	-0.27	0.55	0.14	0.82
2	1845	-0.19	0.74	0.28	0.93
3	710	-0.27	0.55	0.12	0.82
3	1936	-0.16	0.72	0.28	0.88
4	801	-0.27	0.43	0.08	0.69
4	2026	-0.22	0.54	0.17	0.76
5	851	-0.33	0.38	0.03	0.70
5	2116	-0.12	0.60	0.24	0.72
6	942	-0.19	0.41	0.10	0.59
6	2207	-0.22	0.43	0.10	0.65
7	1032	-0.30	0.48	0.10	0.78
7	2257	-0.21	0.34	0.04	0.54
8	1122	-0.43	0.37	-0.02	0.80
8	2348	-0.33	0.33	-0.01	0.66
9	1213	-0.47	0.46	0.02	0.93
10	38	-0.34	0.41	0.04	0.76
10	1303	-0.46	0.59	0.08	1.05
11	128	-0.33	0.51	0.09	0.84
11	1354	-0.43	0.73	0.15	1.16
12	219	-0.49	0.43	-0.04	0.92
12	1444	-0.59	0.80	0.12	1.39
13	309	-0.57	0.47	-0.06	1.04
13	1534	-0.62	0.87	0.14	1.48
14	400	-0.56	0.57	0.00	1.13
14	1625	-0.54	0.93	0.21	1.47
15	450	-0.55	0.57	0.00	1.12
15	1715	-0.58	1.03	0.26	1.61
16	540	-0.43	0.63	0.10	1.07
16	1805	-0.51	0.94	0.24	1.46
17	631	-0.47	0.59	0.05	1.06
17	1856	-0.49	0.81	0.17	1.30
18	721	-0.52	0.60	0.03	1.12
18	1946	-0.11	1.09	0.48	1.20
19	811	-0.10	0.88	0.39	0.98
19	2037	-0.13	0.94	0.41	1.07
20	902	-0.23	0.67	0.23	0.90
20	2127	-0.29	0.64	0.17	0.93
21	952	-0.44	0.53	0.06	0.97
21	2217	-0.38	0.47	0.05	0.85
22	1043	-0.53	0.53	0.00	1.06
22	2308	-0.47	0.33	-0.05	0.80
23	1133	-0.53	0.62	0.05	1.14
23	2358	-0.33	0.49	0.10	0.82
24	1223	-0.38	0.75	0.18	1.12
25	49	-0.41	0.35	-0.01	0.76
25	1314	-0.52	0.63	0.04	1.16
26	139	-0.53	0.32	-0.08	0.85
26	1404	-0.52	0.66	0.08	1.18
27	229	-0.41	0.43	0.03	0.84
27	1455	-0.36	0.73	0.18	1.09
28	320	-0.45	0.39	-0.02	0.84
28	1545	-0.40	0.76	0.17	1.15
29	410	-0.38	0.48	0.06	0.87
29	1635	-0.33	0.81	0.25	1.14
30	501	-0.29	0.50	0.11	0.79
30	1726	-0.27	0.71	0.22	0.98
31	551	-0.37	0.46	0.04	0.84
31	1816	-0.21	0.74	0.25	0.95

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in April and the two surveys in May on profile line 188, located 517 m south of the pier. The only significant change occurred in the nearshore where the trough (160 m) filled in resulting in a 240 m long plateau (160 - 280 m). Only minor changes are visible on the remainder of the profile.

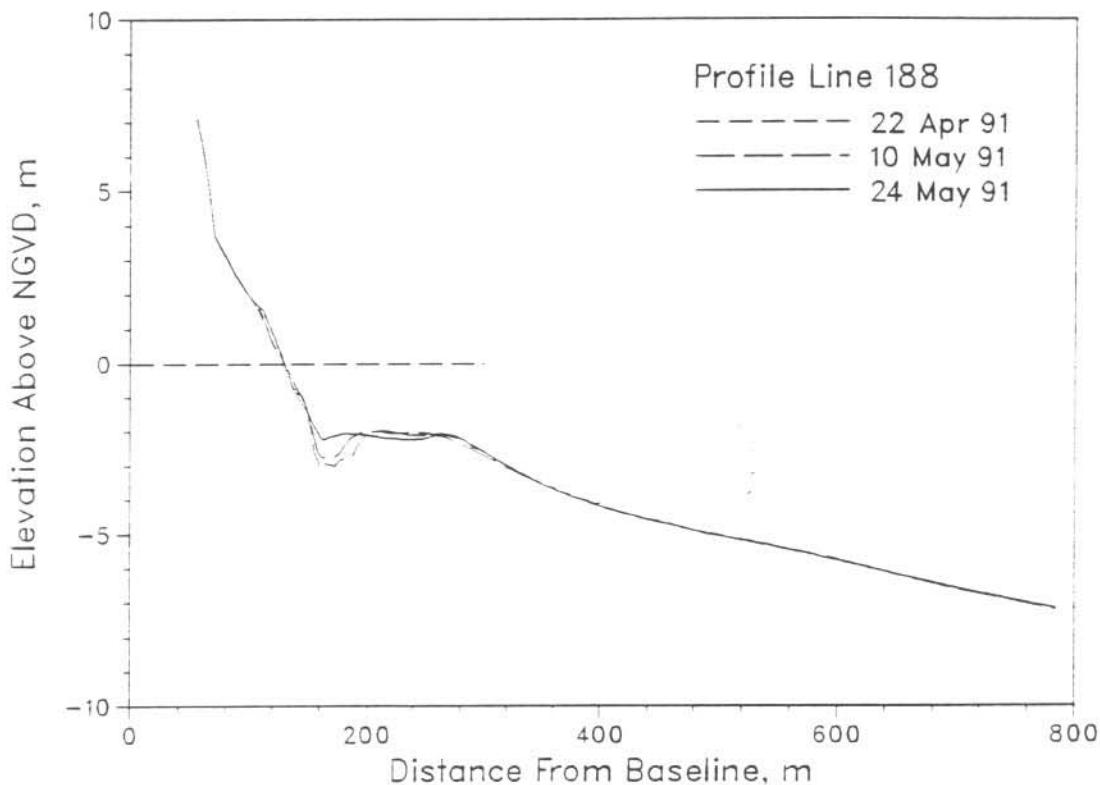


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1991. Causes for the changes visible on the envelope include the filling of the nearshore trough (180 m) and a small amount of accretion on the foreshore (120 - 140 m).

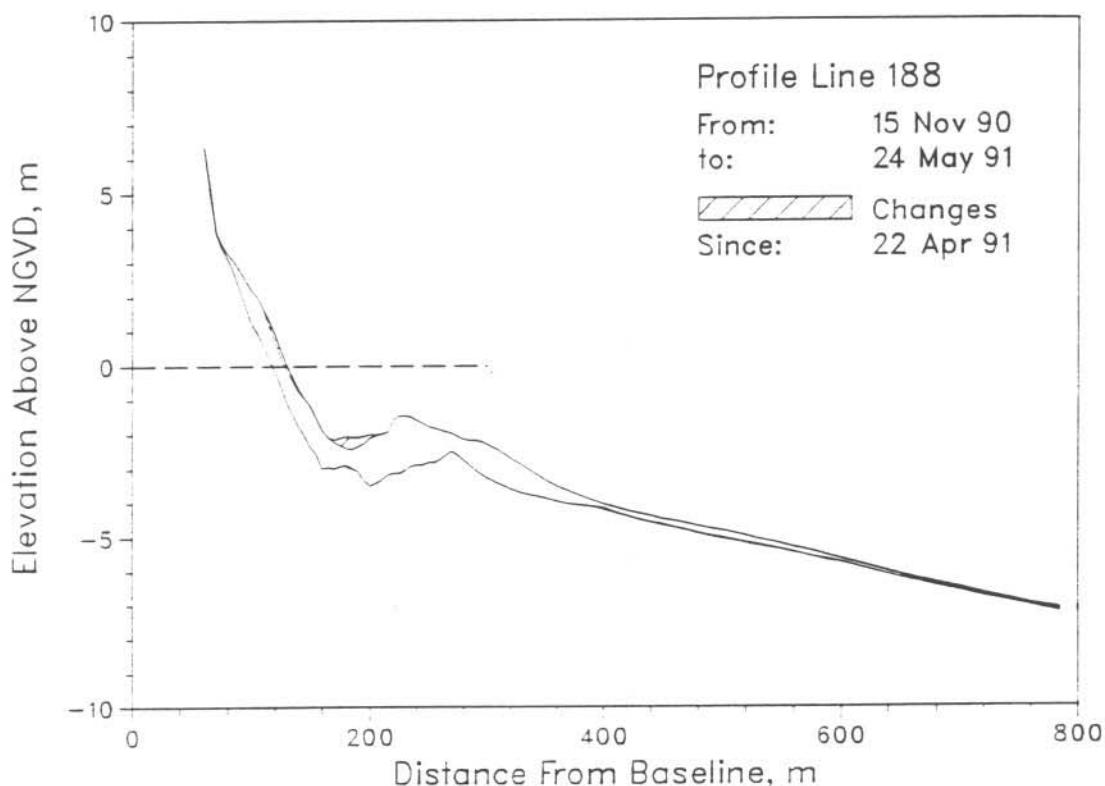


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 8 May. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

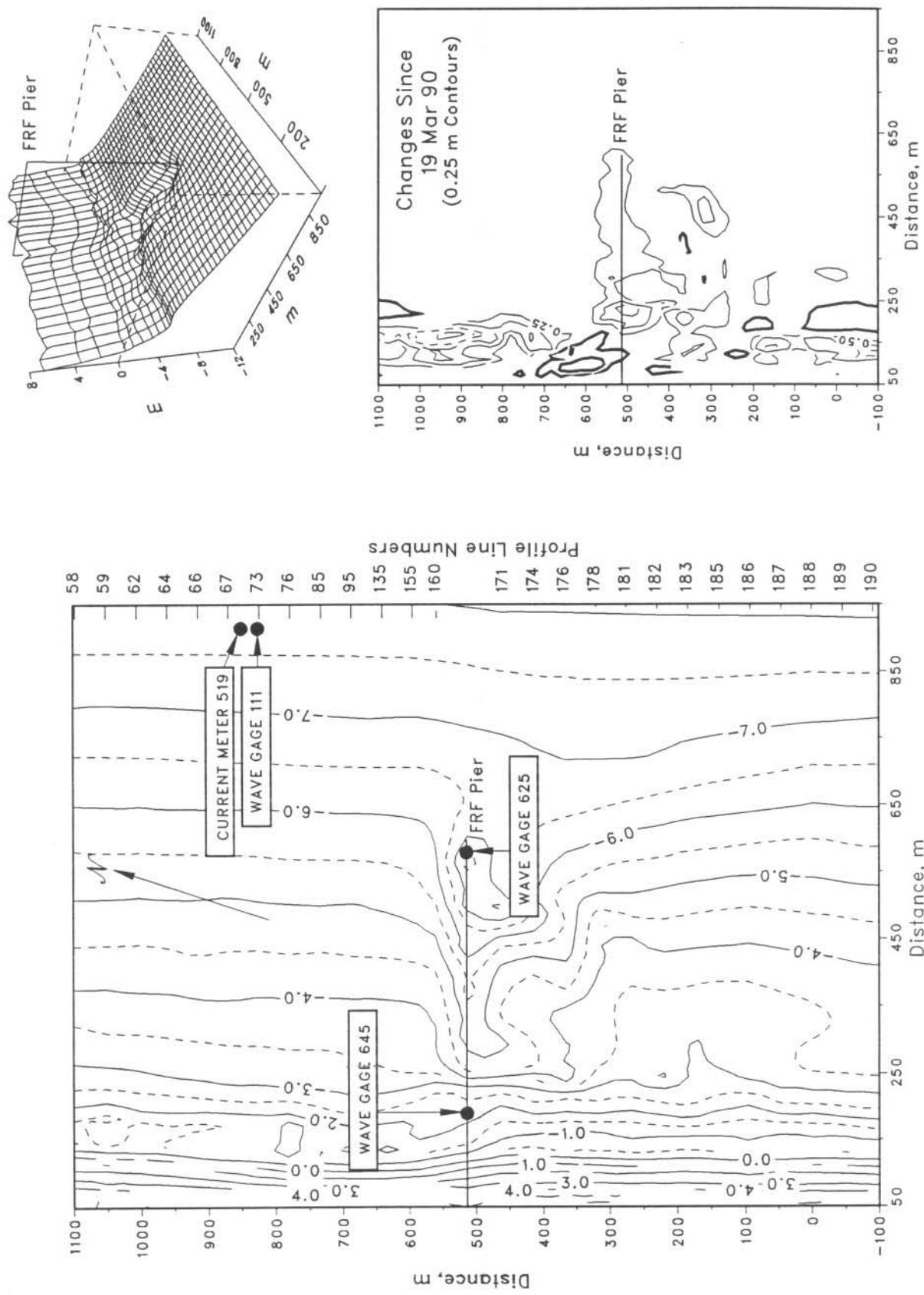


Figure 7. FRF bathymetry 8 May 90 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
18 May (1816)	19 May (1742)

B. Storm Synopsis.

18-19 May - Winds from a strong Canadian high pressure system began to generate storm waves at the FRF late on 18 May. The maximum H_{mo} (at gage 625) of 2.43 m ($T_p = 6.92$ sec) was attained at 1000 EST on 19 May. Maximum winds (from northeast) neared 14 m/s at 0842 EST, also on 19 May.

Distribution List

Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

Colleges/Universities:

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East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
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Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
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Southern Illinois University	

Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
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W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of New South Wales (Australia)
University of Sydney (Australia)